Honors Chemistry - Nature of Science

Stasya

"The meeting of two personalities is like the contact of two chemical substances: if there is any reaction, both are transformed." — Carl Gustav Jung

Note: It is expected that you try the examples to the best of your understanding, and complete the problem sets by the test date and ask for help where needed.

1 Laboratory Safety

There are few rules for the lab.

You must protect your eyes while in the lab. Googles should be worn at all times.

Your clothing should cover your legs, and no loose clothing - these can dip into chemicals or catch on fire.

Protect your feet - broken glass is frequently found in the lab.

Dangling hair can catch fire in the Bunsen burner or fall in a chemical solution, so tie back loose hair.

Do not eat or drink in the lab, this is how chemicals are ingested.

Do not taste chemicals or smell chemicals directly.

Heat test tubes at an angle away from you or anybody else.

Handle hot glassware the with the correct tongs.

Carry out lab experiments assigned by your teacher with your teacher present.

Never work alone in a lab.

Dispose of waste according to the procedure or your teacher's instructions.

Never remove chemicals from the lab.

Wash your hands with soap and water after leaving.

Report any accidents or unsafe conditions immediately.

Here are some safety equipment:
The eye wash fountain
The safety shower
The fire extinguisher
The emergency exit

Safety Data Sheets tell you all information about a chemical that you need to know.

2 Lab Equipment

A beaker is used to hold liquids, but they do not precisely measure.

A test tube holds small amounts of liquids.

An erlenmeyer flask is used to hold liquids and swirl mixtures.

A test tube rack is used to hold test tubes.

A bunsen burner is used to heat with intensity.

A hot plate is used to heat at a wide variety of temperatures, from low to high.

A plastic pipette is used to transfer small approximate amounts and it not used for measuring.

A volumetric flask is used for making solution of a specific volume. It only has one line for measuring.

Beaker tongs are used to pick up hot beakers.

Test tube tongs are used to hold one test tube.

Crucible tongs are used to pick up a crucible or hold something in flame.

Ring stands are used for holding items over flame for a long period of time

or filtering.

Wire gauzes are used to put a hot beaker on, rather than the lab table to prevent shattering.

Balances are used to measure the mass of an object.

Glass pipettes are used to measure small amounts of liquids by suction.

Graduated cylinders measure the volume of a liquid.

3 Matter, Energy, and Change

Now we start with chemistry.

Chemistry is the science that investigates the structures and properties of matter, and the changes that matter undergoes.

Matter is defined as anything composed of atoms, such as people, cars, and food.

Mass is a measure of how much matter is in an object.

Weight is a measure of gravity's pull on matter.

Volume is how much space is taken up.

Now Stop and Think - What is the difference between mass and weight and what instruments do we use to measure mass and weight?

There are two types of data:
1. Qualitative: qualities (senses, adjectives)
2. Quantitative: quantities (numbers, measurements)

When graphing data there will be two variables:
1. Independent (the one that is being controlled and found on the x-axis)
2. Dependent (the result which is found on the y-axis)

There are two types of measurable properties:
1. Extensive (property that depends on how much matter you have)
2. Intensive (property that is independent of the amount of matter)

Physical vs Chemical Changes and Properties All matter exhibits phys-

ical and chemical properties by which it can be classified. A physical property can be observed without a chemical change occurring. Chemical properties can only be observed when a chemical change occurs.

Physical changes include changes of state where atoms are not rearranged into new substances.
These could include changes in size, shape, or dissolving.

Chemical changes happen when bonds are broken and new bonds are formed to make new substances.
These tend to be more interesting than physical changes.

There are four indicators of a chemical change:
1. Energy change - heat or light is given off
2. Production or evolution of a gas
3. Precipitate formation - when a solid is formed when two clear liquids are mixed together.
4. Color change

4 Classification of Matter

Mixtures have varying composition and are made up of two or more pure substances that can be separated by physical changes.

There are two types of mixtures:
1. Homogeneous - uniform in composition throughout a given sample
2. Heterogeneous - with separate, distinct regions within the sample with a composition and properties that vary from one part of the mixture to another.

A pure substance is a material that is made of only one type of atom or only one type of molecule.

The most common of this is an element, one of the 118+ pure substances that cannot be separated by chemical or physical change. Every element is composed of only one type of atom and is represented by a symbol on the periodic table.

An allotrope is the same element with different bonding of atoms and has different properties.

A compound is made from atoms that are chemically bonded together. These can be separated by chemical change, but not physical change. Compounds always have a fixed composition of atoms and so are represented by formulas using the symbols on the periodic table.

Think! How is bonding different from mixing?

There are a few laws in chemistry:
1. The Law of Definite Proportions: This states that all samples of a compound contain the same elements in the same proportions.
2. Law of Multiple Proportions: This states that if elements combine to make more than one compound, the masses will be small, whole number ratios.
3. Law of Conservation of Mass: This states that matter cannot be created or destroyed in any type of change.
4. Law of Conservation of Energy: This states that energy cannot be created or destroyed.

The Periodic Table Find the zig-zag line. To the left of the zig-zag line are the metals. To the right are the non metals. Elements that touch the line are metalloids.
Vertical columns are called groups and horizontal rows are called periods.

5 Measurement

There is a difference between accuracy and precision. Accuracy is how close a measurement is to the accepted value. Precision is how close a series of measurements is to each other.

Percent Error Percent error indicates the accuracy of a measurement. The data found in experiments often differ from the accepted value.

Percent error is defined as $\%\text{error} = \left|\frac{\text{accepted value} - \text{experimental value}}{\text{accepted value}}\right| \times 100$.
Example: Suppose you calculate your semester grade in chemistry as 90.1, but you receive a grade of 89.4 on your report card. What is your percent error?

Solution: 0.8%.

When reporting the instrument data, report what is known with certainty and then add one digit of uncertainty.

Significant Figures These indicate the accuracy of a measurement. It is important to be honest when reporting a measurement, so that it does not appear to be more accurate than the equipment used to make the measurement.

Rules for counting Sig Figs:
1. All nonzero digits are significant.
2. Sandwiched zeroes are significant.

3. Zeroes at the beginning are never significant.
4. Zeroes at the end are significant only if you can see the decimal point.
5. Exact numbers have an unlimited number of significant figures.
6. In scientific notationm the 10^x part of the number is never significant.

Scientific Notation
Scientific notation is called that because in science, we may be dealing with very large or small numbers.
To convert numbers in standard form into scientific notation:
1. Move the decimal until there's 1 non-zero digit to its left. The amount of places moved is the exponent.
2. If the number in standard form is greater than 1, there will be a positive exponent, otherwise it will be a negative exponent.
3. Only include sig figs when writing a number in scientific notation.

When converting numbers in scientific notation into standard form:
If the exponent is positive move the decimal that many places to the right, otherwise if the exponent is negative, move the decimal that many places to the left.

Mathematical Operations with Sig Figs
When combining measurements with differing degrees of accuracy and precision, the accuracy of the final answer can be no greater than the least accurate measurement.

When adding or subtracting, limit the answer to the same number of decimal places that appear in the original data with the fewest number of decimal places.

When multiplying or dividing, limit the answer to the same number of significant figures that appear in the original data with the fewest number of significant figures.

6 Density

Density is a property of matter that is determined by what the matter is. The density of 1 gram of iron is the same as the density of 10 grams of iron.

Density depends on how tightly packed the atoms are and what kind of atoms they are.

Density is calculated by $D = \frac{m}{v}$.

Example: What is the density of a piece of wood that has a mass of 35.99 g and a volume of 45.68 cm^3.

Solution: 0.7879 g/cm^3

7 Dimensional Analysis

In chemistry we use the metric system. This means we use grams, meters, and liters. Prefixes you should know are:
kilo - 1000
centi - 1/100
milli - 1/1000

Example: Convert 25.4 mL to L.

Solution: 0.0254 L